

# In adults, what is the relationship between the intake of vegetables and fruits, not including juice, and cardiovascular disease?

## Conclusion

Consistent evidence suggests at least a moderate inverse relationship between vegetable and fruit consumption with myocardial infarction and stroke, with significantly larger, positive effects noted above five servings of vegetables and fruits per day. Notwithstanding prior work on dietary patterns that emphasize vegetables and fruits, insufficient evidence published since 2004 is available to assess the independent relationship between vegetable and fruit intake and blood pressure or serum cholesterol.


## Grade: Moderate

Overall strength of the available supporting evidence: Strong; Moderate; Limited; Expert Opinion Only; Grade not assignable For additional information regarding how to interpret grades, [click here](#).

## Evidence Summary Overview

Evidence suggests at least a moderate inverse relationship between vegetable and fruit consumption with myocardial infarction (MI) and stroke, with significantly larger, positive effects noted above five servings of vegetables and fruits per day. This evidence is based on 12 reports including four meta-analyses (Dauchet, 2005; Dauchet, 2006; He, 2006; He, 2007) of US and European subjects; six prospective studies, four of which were conducted in the US (Genkinger, 2004; Hung, 2004; Joshipura, 2009; Tucker, 2005) and two in Japan (Nakamura, 2008; Takachi, 2008), and two international case-control studies (Galeone, 2009; Nikolic, 2008). Results varied by sex, with a significant decrease for men and women reported in all-cause cardiovascular death (Genkinger, 2004; Hung, 2004; Joshipura, 2009), for men only (Tucker, 2005), for men only in terms of vegetable intake (Nakamura, 2008), and for women only in terms of fruit intake (Nakamura, 2008). In addition, Takachi (2008) found significant results for higher fruit (but not vegetable) intake in men and women. Risk for cardiovascular disease (CVD) is highest at consumption levels below three servings per day, results are ambiguous at three to five servings of vegetables and fruits per day, and lowest risk is associated with consumption levels above five servings per day (Dauchet, 2006; He, 2007), suggesting a linear relationship between vegetable and fruit consumption and coronary heart disease (CHD). Overall, risk reduction for CHD was estimated to be as much as 4% and 11% for stroke alone for each serving of vegetables and fruits added per day (Dauchet, 2006).

## Relationship between Intake of Vegetables and Fruits and Cardiovascular Disease

Study	Study Type	Association: Pos, Neg, None
<i>Dauchet et al, 2005</i>  Quality rating: 	Meta-analysis, nine prospective cohort studies.	CHD: (-) Vegetable and/or fruit, decreased risk for each additional daily portion.

<i>He et al, 2007</i> Quality rating: 	Meta-analysis, 13 prospective cohort studies.	CHD: (-) Vegetable and fruit, decreased risk for those with 5+ servings a day.
<i>Dauchet et al, 2006</i> Quality rating: 	Meta-analysis, seven prospective cohort studies.	Stroke: (-) Vegetable and fruit, (-) fruit, Ø vegetables, decreased risk for each additional daily portion.
<i>He et al, 2006</i> Quality rating: 	Meta-analysis, nine prospective cohort studies.	Stroke: (-) Vegetable and fruit, decreased risk for those with 5+ servings a day.
<i>Genkinger et al, 2004</i> Quality rating: 	Prospective cohort study CLUE Cohorts, US.	CVD mortality: (-) Vegetable and fruit, (-) cruciferous vegetables.
<i>Hung et al, 2004</i> Quality rating: 	Prospective cohort study Nurses' Health and Health Professionals' Follow Up Studies, US.	CVD: (-) Vegetable and/or fruit, (-) vitamin C-rich fruit, (-) green leafy vegetable.
<i>Joshi et al, 2009</i> Quality rating: 	Prospective cohort study Nurses' Health and Health Professionals' Follow Up Studies, US.	CVD: (-) Vegetable, stronger relationship among those consuming low-CHO diet.
<i>Nakamura et al, 2008</i> Quality rating: 	Prospective cohort study Japan.	CVD mortality: (-) Vegetable (women), Ø vegetable (men), Ø fruit (men or women).
<i>Takachi et al, 2008</i> Quality rating: 	Prospective cohort study Japan Public Health Center Study, Japan.	CVD: Ø Vegetable and fruit, (-) fruit, Ø vegetable (some sex differences).
<i>Tucker et al, 2005</i> Quality rating: 	Prospective cohort study Baltimore Longitudinal Study of Aging, US.	CHD mortality: (-) Vegetable and fruit, Ø fruit, (-) vegetable.
<i>Galeone et al, 2009</i> Quality rating: 	<u>Case-control study</u> Italy.	Acute MI: (-) Allium vegetable intake.
<i>Nikolic et al, 2008</i> Quality rating: 	Case-control study Serbia.	Acute CHD: (-) Vegetable, (-) fruit.

## Evidence Summary Paragraphs

### *Meta-analyses of Prospective Cohort Studies*

**Dauchet et al, 2006** (positive quality), a meta-analysis of nine prospective cohort studies (seven from the US and two from Finland), assessed the magnitude of the relation between fruit and vegetable consumption and the risk of CHD. The meta-analysis consisted of 91,379 men, 129,701 women and 5,007 CHD events. Risk of CHD was decreased by 4% (RR=0.96; 95% CI: 0.93, 0.99; P=0.0027) for each additional daily portion of fruit and vegetables and by 7% (RR=0.93; 95% CI: 0.89, 0.96; P<0.0001) for each additional daily portion of fruit. The association between vegetable intake and risk of CHD was heterogeneous (P=0.0043), more marked for cardiovascular mortality (RR=0.74; 95% CI: 0.75, 0.84; P<0.0001) than for fatal and non-fatal MI (RR=0.95; 95% CI: 0.92, 0.99; P=0.0058). The authors reported a beneficial association between fruit and vegetable intake and CHD risk; however, they noted that the strength of this association is uncertain, because of possible publication or selection bias. Note: Seven studies in common with He, 2007.

**He et al, 2007** (positive quality), a meta-analysis assessed quantitatively the relation between fruit and vegetable intake and the incidence of CHD by using data from 13 prospective cohort studies

(nine from the US and four from Europe). The data comprised a total of 278,459 individuals and 9,143 events over a median of 11 years of follow-up. Relative risk (RR) or hazard ratio (HR) was used as a measure of the relation between fruit and vegetable intake and CHD. Individuals with higher fruit and vegetable intake had a lower risk of CHD. Compared with individuals who had less than three servings per day of fruit and vegetables, the pooled RR of CHD was 0.93 (95% CI: 0.86, 1.00; P=0.06) for those with three to five servings per day and 0.83 (95% CI: 0.77, 0.89; P<0.0001) for those with more than five servings per day. Compared with individuals who had less than three servings per day of fruits and vegetables, the pooled RR of MI was 0.94 (95% CI: 0.80, 1.10; P=0.43) for those with three to five servings per day and 0.83 (95% CI: 0.70, 0.99; P=0.04) for those with more than five servings per day. Compared with those who had fruit and vegetable intake of less than three servings per day, individuals with more than five servings per day had a significantly lower risk of CHD irrespective of subjects' gender, duration of follow-up, and method of dietary assessment. However, this association was not significant (NS) in studies where dietary assessment was completed via interview. For individuals with fruit and vegetable intake of three to five serving a day, the association was only significant in some subgroups. The authors concluded that their results provide support for the recommendation to consume more than five servings per day of fruit and vegetables. Note: Seven studies in common with Dauchet, 2006.

**Dauchet et al, 2005** (positive quality), a meta-analysis assessed the relationship between fruit consumption, vegetable consumption and both fruit and vegetable consumption and the risk of stroke. Analyses included seven prospective cohort studies (five from the US, one from Europe, and one from Japan) that studied the relationship between stroke and the consumption of fruit and vegetables, separately or combined. The risk of stroke was decreased by 11% (pooled RR=0.89; 95% CI: 0.85, 0.93) for each additional portion of fruit per day, by 5% (pooled RR=0.95; 95% CI: 0.92, 0.97) for fruits and vegetables, and by 3% (pooled RR=0.97; 95% CI: 0.92, 1.02; not significant) for vegetables. The associations for fruit as well as fruits and vegetables were linear, suggesting a dose response relationship. In contrast, there was NS evidence for a substantial reduction in stroke rates with vegetable consumption. Note: Six studies in common with He, 2006.

**He et al, 2006** (positive quality), a meta-analysis assessed quantitatively the relation between fruit and vegetable intake and the incidence of stroke by using data from nine prospective cohort studies (five from the US, three from Europe and one from Japan). The data comprised a total of 257,551 men and women, 4,917 events and a median of 13 years of follow-up. The results showed that individuals with an increased fruit and vegetable intake have a reduced risk of stroke. Compared with individuals who had less than three servings per day of fruit and vegetables, the pooled RR of stroke was 0.89 (95% CI: 0.83, 0.97; P=0.005) for those with three to five servings per day and 0.74 (95% CI: 0.69, 0.79; P<0.0001) for those with more than five servings per day. Compared with individuals who had less than three servings per day of fruits and vegetables, those with more than five servings per day had a significantly reduced risk of stroke, irrespective of sex, duration of follow-up, method of dietary assessment, dietary instrument administration or stroke subtype. For individuals who had three to five servings per day, the association was significant only in some groups. This study showed that increased consumption of fruit and vegetables from less than three to more than five servings per day was related to a 26% reduction in the risk of stroke, whereas increasing the intake to three to five servings per day was associated with an 11% reduction in the risk of stroke. Note: Six studies in common with Dauchet, 2005.

### ***Prospective Cohort Studies***

**Genkinger et al, 2004** (positive quality), a prospective cohort study conducted in the US, assessed the relationship of fruit and vegetable and dietary vitamin C, vitamin E and beta-carotene intake with all-cause, CVD and cancer mortality in the community-based CLUE cohorts in Washington County,

Maryland. 5,952 participants (63% female, 99% white) were included in the analysis and 378 CVD deaths occurred over 12 years of follow-up. Compared with those in the bottom quintile (median = 0.87 servings per day), participants in the highest quintile (median = 4.89 servings per day) of fruit and vegetable intake had a lower risk of all-cause mortality (HR=0.63; 95% CI: 0.51, 0.78; P for trend = 0.0004) and CVD mortality (HR = 0.76; 95% CI: 0.54, 1.06; P for trend = 0.15). Higher intake of cruciferous vegetables was associated with lower risk of CVD mortality (HR=0.89; 95% CI: 0.64, 1.25; P for trend = 0.51). A further analysis evaluated the association of mortality with the recommended daily consumption of five or more servings per day of fruits and vegetables. Only 9% of participants reported five or more servings per day of fruits and vegetables; no association was present for CVD mortality (HR=1.04; 95% CI: 0.76, 1.42).

**Hung et al, 2004** (positive quality), a prospective cohort study examined the association between fruit and vegetable consumption and the risk of major chronic diseases in two large cohorts of men and women followed for more than a decade. The data was from participants in the Nurses' Health Study (NHS), who were nurses aged 30 to 55 years recruited in 1976, and participants in the Health Professionals' Follow-Up Study (HPFS), who were health professionals aged 40 to 75 years recruited in 1986. Additional mailed questionnaires were completed in 1986, 1990 and 1994 for the NHS and 1990 and 1994 for the HPFS. The analyses included 71,910 women and 37,725 men. Study end dates were May 31, 1998 for the NHS and January 31, 1998 for the HPFS. During follow-up, 1964 CVD events were ascertained in women, and 1670 CVD events in men. For CVD, the pooled RR in the continuous analysis was statistically significant. RR of CVD was 0.88 (95% CI: 0.81, 0.95) for an increment of five servings per day of total fruits and vegetables; 0.87 (95% CI: 0.80, 0.94) and 0.93 (95% CI: 0.86, 1.00) for increments of three servings per day of all fruits and all vegetables, respectively; and 0.89 (95% CI: 0.83, 0.96) and 0.94 (95% CI: 0.91, 0.98) for increments of one serving per day of green leafy vegetables and of vitamin C-rich fruits and vegetables, respectively. Higher fruit and vegetable intake showed a statistically significant inverse association with CVD disease (RR for eight or more vs. less than 1.5 servings a day was 0.70 (95% CI: 0.55, 0.89; P=0.0003).

**Joshipura et al, 2009** (positive quality), a prospective cohort study, examined whether carbohydrate intake affects the association between fruits and vegetables and CVD using data from the Nurses' Health Study (NHS) and Health Professionals' Follow-Up Study (HPFS). Participants in the NHS were nurses aged 30 to 55 years recruited in 1976, while those in the HPFS were professionals aged 40 to 75 years recruited in 1986. Information on ischemic CVD (myocardial infarction and stroke) and fruit and vegetable intake were updated over time using the 1984 to 1998 questionnaires in the NHS and the 1986 to 1998 questionnaires in the HPFS. Participants were 70,870 NHS females and 38,918 HPFS males who were followed 16 and 14 years, respectively. A total of 2,040 incident cases of CVD were documented among men and 1,852 among women. Fruit intake was strongly related with carbohydrate (CHO) intake, but vegetables showed a weak correlation. Total fruit and vegetable intake was 7.6 servings per day among men in high CHO group compared with 4.4 servings per day for men in the low CHO group; among women the intake was 6.9 servings per day in the high CHO group compared with 4.1 servings per day in the low CHO group. Total fruits and vegetables showed a non-significant inverse association among men and women with low energy-adjusted carbohydrate intake, with a pooled RR for an increment of five servings per day of 0.81 (95% CI: 0.65, 1.01; P for trend = 0.06). When comparing extreme quintiles of fruits and vegetables, NS association was seen in the low CHO group (RR=0.73; 95% CI: 0.51, 1.04). Total fruit intake was associated with a lower risk of ischemic CVD only among participants with moderate CHO intake (RR=0.81 comparing extreme quintiles; 95% CI: 0.70, 0.94). No significant linear association was found in any of the CHO intake groups. The linear trend was significant for total vegetables in the low CHO group, with a pooled RR for three servings a day of 0.82 (95% CI:

0.68, 0.99; P for trend = 0.04). Compared with the group with both high fruit and vegetable (more than five servings per day) and high CHO intake (higher than 50% of energy from CHO), the low fruit and vegetable intake and high CHO group showed an increase in CVD for men (RR=1.21; 95% CI: 1.02, 1.42) but not women. After adjustment for CHO intake, there was a significant inverse association between high fruit and vegetable intake and ischemic CVD in men (RR=0.90; 95% CI : 0.82, 0.99) but not women; the association was significant when pooled across the two cohorts: RR=0.91 (95% CI : 0.85, 0.98).

**Nakamura et al, 2008** (positive quality), a prospective cohort study, examined the association between baseline fruit and vegetable intake and CVD mortality in 29,079 Japanese men and women. Two hundred men and 184 women died from CVD during seven years of follow-up. Median intakes of fruit in the lowest and highest quartiles were 0.3 to 2.6 servings per day for men and 0.4 and 2.7 servings per day for women. Median intakes of vegetables in the lowest and highest quartiles were 2.2 and 7.1 servings per day for men and 2.5 and 7.4 servings per day for women. For women, when comparing extreme quartiles of vegetable intake (2.5 vs/ 7.4 servings per day), there was a significant inverse association with CVD mortality after adjusting for total energy, age and non-dietary and dietary covariates (HR=0.62; 95% CI: 0.36, 1.08; P for trend = 0.007). Fruit intake was NS associated with CVD deaths among women. For men, CVD death was not associated with fruit or vegetable intake.

**Takachi et al, 2008** (positive quality), a prospective cohort study conducted in Japan, examined the association between fruit and vegetable consumption and risk of CVD. The Japan Public Health Center-based Prospective Study was conducted on two cohorts, one initiated in 1990 and one in 1993. During 1995 to 1998, a food-frequency questionnaire (FFQ) was administered in nine areas to 77,891 men and women. During 459,320 person-years of follow-up until the end of 2002, 1,386 CVD cases were identified. Total fruit and vegetable intake ranged from a median value of 186g per day in the lowest quartile to 733g per day in the highest quartile. Higher consumption of fruit, but not vegetables, was associated with significantly lower risk of CVD; multivariate HR for highest vs. lowest quartiles of intake were 0.81 ( 95% CI: 0.67, 0.97; P for trend = 0.01) for fruit. Total fruit and vegetable intake was NS associated with CVD risk. The only specific fruit or vegetable significantly inversely associated with CVD risk was citrus fruits (HR=0.80; 95% CI: 0.67, 0.95; P for trend = 0.02). Cardiovascular disease risk for women was significantly inversely associated with total fruit and vegetable consumption (multivariate HR of highest vs. lowest quartiles = 0.73, 95% CI: 0.56, 0.95; P for trend = 0.02) and with fruit consumption (HR=0.78, 95% CI: 0.60, 1.01; P for trend = 0.06), and a NS, inverse association with vegetable consumption (HR=0.81, 95 % CI: 0.63, 1.05; P for trend = 0.14). No association between fruit or vegetable consumption and risk of CVD was found for men.

**Tucker et al, 2005** (positive quality), a prospective cohort study conducted in the US, examined associations between habitual fruit and vegetable intake and saturated fat intake, separately and in combination, and subsequent coronary heart disease and total mortality among men in the Baltimore Longitudinal Study of Aging (BLSA). Dietary data were collected by seven-day diet records during four time periods and completed diet records at biennial visits. A total of 501 men were included in the analysis. After adjustment for covariates, each serving of fruits and vegetables was associated with a 6% reduction in risk for total mortality (P<0.05) and a 21% reduction in CHD death (P<0.01). When examined separately, intake of fruit was associated inversely with total mortality (P<0.05) and intake of vegetables was inversely associated with CHD mortality (P<0.01), with a risk reduction of 40% per serving. When examined together, participants consuming more than five servings of fruits and vegetables per day and less than 12% of energy intake came from saturated fat were 31% less likely to die of any cause (P<0.05) and 76% less likely to die from CHD (P<0.001).

## Case-Control Studies

**Galeone et al, 2009** (neutral quality), a case-control study conducted in Italy, determined the relationship between allium vegetable intake (such as onions and garlic) and risk of acute MI in 760 patients (76% male; median age = 61 years) with a first episode of non-fatal acute MI and 682 controls (64% male; median age = 59 years) admitted to the same hospitals between 1995 and 2003. Compared with non-onion-consumers, the odds ratios (OR) of acute MIs for subsequent categories of onion intake were 0.90 (95% CI: 0.69, 1.21) for less than one portion of onion per week and 0.78 (95% CI: 0.56, 0.99) for more than one portion per week (P for trend = 0.05). For garlic consumers, the ORs were 0.84 (95% CI: 0.66, 1.09) for intermediate and 0.94 (95% CI: 0.68, 1.32) for high use, compared with low or no garlic use (P for trend = 0.50).



**Nikolic et al, 2008** (neutral quality), a case-control study examined the relationship between vegetable and fruit intake and the risk of CHD using data from a case-control study conducted from 2001 to 2003 in Serbia. The subjects were selected randomly: 290 cases with a first event of acute coronary syndrome and 290 selected paired controls by sex, age and region. Participants in the lowest tertile of vegetable consumption had 4.04 (95% CI: 1.51, 11.41) times higher odds of CHD compared to participants in the upper tertile of consumption. The OR for the middle tertile of vegetable consumption compared to the upper tertile was 1.06 (95% CI: 0.69, 1.65). Participants who consumed between one serving of fruit a day and one serving a week had 1.78 (95% CI: 1.12, 2.87) times greater odds of CHD compared to those who consumed more than one serving per day. These findings support an inverse relation between vegetable and fruit intake and CHD.




## Blood Pressure

Five studies investigating blood pressure and vegetable and fruit intake were identified in the Nutrition Evidence Library (NEL) search. These included the PREMIER prospective cohort study in the US (Wang, 2008), one prospective study in Spain (Nuñez-Cordoba, 2009); cross-sectional studies in Iran (Mirmiran, 2009), Japan (Utsugi, 2008) and India (Radhika, 2008). Two studies showed no association between total vegetable and fruit intake and blood pressure (BP) (Mirmiran, 2009) and hypertension (HTN) (Nuñez-Cordoba, 2009). Utsugi et al (2008) showed a significant positive relationship with vegetable and fruit consumption and lower risk of home-measured HTN. The Wang et al (2008) study showed vegetable and fruit consumption was inversely associated with both systolic blood pressure (SBP) and diastolic blood pressure (DBP) at six months, but not at 18 months.

The US results support the work reviewed in the 2005 Dietary Guidelines Advisory Committee (DGAC) report, but the international studies do not. The variation in results may be due to differences between these international population samples and typical American patterns in baseline consumption levels of vegetables and fruits, types of vegetables and fruits consumed and overall dietary patterns.

## Relationship between Intake of Vegetables and Fruits and Blood Pressure

Study	Study Type	Association: Pos, Neg, None
<i>Nuñez-Cordoba et al, 2009</i> Quality rating: 	Prospective cohort study SUN Cohort, Spain.	HTN: Ø Vegetable, Ø fruit, Ø vegetable and fruit.
<i>Wang et al, 2008</i> Quality rating: 	Prospective cohort study PREMIER, US.	SBP and DBP (six months): (-) Vegetable and fruit HTN: (-) Vegetable and fruit at six months, but not 18 months.

<i>Mirmiran et al, 2009</i> Quality rating: 	Cross-sectional Iran.	BP: Ø Vegetable and fruit.
<i>Radhika et al, 2008</i> Quality rating: 	Cross-sectional India.	SBP: (-) Vegetable and fruit. DBP: Ø Vegetable and fruit.
<i>Utsugi et al, 2008</i> Quality rating: 	Cross-sectional Japan.	HTN (self-measured): (-) Vegetable, (-) fruit

### ***Prospective Cohort Study***

**Núñez-Cordoba et al, 2009** (positive quality), a prospective cohort study in Spain, assessed the association between fruit and vegetable consumption and the risk of HTN. A total of 8,594 participants (mean age = 41.1 years; 62% female) from the Mediterranean Study (SUN cohort) were included in analyses. Dietary habits were assessed with a validated semi-quantitative FFQ (136 items). Hypertension was self-reported. Over a median of 49 months of follow-up, 426 cases of HTN were reported. No significant associations between servings per day of fruits [multivariate HR between highest (more than four servings a day) and lowest (one or less serving a day) quintiles = 0.85; 95% CI: 0.59, 1.22; P for trend = 0.70], vegetables [multivariate HR between highest (more than four servings a day) and lowest (one or less serving a day) quintiles = 0.87; 95% CI: 0.55, 1.39; P for trend = 0.61], or fruits and vegetables combined [multivariate HR between highest (five or more servings a day) and lowest (two or less servings a day) quartiles = 0.78; 95% CI: 0.55, 1.10; P for trend = 0.22] and HTN were observed.

**Wang et al, 2008** (positive equality) examined the association of dietary protein intake with BP, and particularly, the independent relationship of animal and plant protein with BP over 18 months of follow-up. Additional analyses examined the relationship between fruit and vegetable intake and BP. Participants were 810 adults (62% female; age 25 to 79 years) from the PREMIER Trial (US). Blood pressure measurements were obtained by study personnel at baseline, six and 18 months. Two 24-hour recalls, one on a weekday and the other on a weekend day, were obtained at baseline, six and 18 months. Fruit and vegetable intake was inversely associated with both SBP and DBP cross-sectionally at six months (P=0.0003 and 0.0157, respectively). Furthermore, increased intake of fruits and vegetables was significantly associated with a lower risk of HTN at six but not at 18 months. Using multiple logistic regression analyses (including fruits and vegetables, dairy food, meat and fat), only fruit and vegetable intake was significantly and inversely associated with risk of HTN. For every extra serving of fruit or vegetable, the odds of having HTN decreased by about 23% (OR=0.77; 95% CI: 0.79, 0.97; P=0.0041). The authors concluded that other studies showing that regular consumption of fruits and vegetables, nuts/seeds, whole grains and soy products is likely to benefit BP.

### ***Cross-Sectional Studies***

**Mirmiran et al, 2009** (positive quality), a cross-sectional study in Iran, evaluated the association of fruit and vegetable intake and CVD factors. Data (N=840; aged 18 to 74 years) from the Tehran Lipid and Glucose Study (TLGS) was used. Dietary intake was assessed using a semi-quantitative FFQ (168 items). Weight, height, medical history, physical activity and glucose and lipid concentrations were also measured. Mean consumption of fruit and vegetables was 5.6±3.4 servings per day. No significant differences were observed between BP of participants in category one (the lowest category) and those in category four of fruit and vegetable intake.

**Radhika et al, 2008** (positive quality), a population-based cross-sectional study, evaluated the




association of fruit and vegetable intake with cardiovascular risk factors such as obesity, HTN, fasting plasma glucose and dyslipidemia in urban Asian Indians living in southern India. A total of 983 adults were included in the analysis. Dietary intake was assessed with an interviewer-administered semi-quantitative FFQ. Intake of fruit and vegetables ranged from 141g per day in the lowest quartile to 418g per day in the highest quartile. After adjusting for potential confounders, the highest quartile of fruit and vegetable intake showed a significant inverse association with SBP ( $\beta=-2.6$ mmHg, 95% CI: -5.92, -1.02,  $P=0.027$ ) when compared with the lowest quartile. In energy-, age- and sex-adjusted models, there was a significant inverse association with DBP, but this relationship became insignificant after adjustment for body mass index (BMI).

**Utsugi et al, 2008** (neutral-quality), a cross-sectional analysis of the longitudinal Ohasama study in Japan, investigated the association of fruit and vegetable consumption with the risk of HTN diagnosed by home BP in 1,569 adults (aged 35+ years; 59% female). All participants measured their BP at home using a validated device. Dietary intake was assessed with a valid FFQ. The mean consumption of fruits and vegetables were 108 and 63g per day, respectively. The prevalence of home HTN was 39.4% for men and 29.3% for women. In the sex- and BMI adjusted analysis, the highest-tertile of fruit consumption showed a significant relationship with a lower risk for home HTN (the highest-tertile for fruit consumption: OR=0.65;  $P=0.011$ ). After adjustment for known risk factors, these associations did not change. The highest vegetable consumption tertile also showed a significant positive association with lower risk of home HTN (OR=0.62,  $P=0.029$ ).

## Blood Lipids

Blood lipids are traditionally used as an intermediate indicator or marker for CVD. The evidence testing the effect of vegetable and fruit intake on blood lipids is sparse, but suggests an associative trend between an increased consumption of vegetables and fruits with lower total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) levels. The evidence is based on three reports since 2004, including one limited trial (Kelley, 2006) and two cross-sectional studies (Mirmiran, 2009; Radhika, 2008). The trend is apparent for total and LDL-C, and persists even after adjustment for education, physical activity and fat intakes. However, significance occurs only when the highest levels of vegetable and fruit intake are compared to the lowest levels of intake and the mechanisms of action are unknown.

## Relationship between Intake of Vegetables and Fruits and Blood Lipids

Study	Study Type	Association: Pos, Neg, None
<i>Kelley et al, 2006</i> Quality rating: 	Time series study, participants consumed cherries daily for 28 days with baseline and post-intervention periods.	TC: Ø; LDL-C: Ø; HDL-C: Ø.
<i>Mirmiran et al, 2009</i> Quality rating: 	Cross-sectional Iran.	TC: (-) Vegetable and fruit; LDL-C: (-) vegetable and fruit; HDL-c: Ø vegetable and fruit.
<i>Radhika et al, 2008</i> Quality rating: 	Cross-sectional India.	TC: (-) Vegetable and fruit; LDL-C: (-) vegetable and fruit; HDL-C not examined.

## Trial

**Kelley et al, 2006** (neutral quality), a time series study conducted in the US, determined the effects of consuming 300g of Bing sweet cherries daily for 28 days on plasma lipids and markers of inflammation in 18 healthy adults (aged 50±1 years; 89% female). The subjects completed a 64-day study with three metabolic periods: Eight-day baseline period, 28-day cherry intervention period and

28-day post-intervention period. Participants were provided cherries in 300g portions. They were asked not to change their activity level or diet except to replace an equivalent amount of dietary carbohydrates with CHO from cherries. Plasma concentrations for TC, LDL-C and high-density lipoprotein cholesterol (HDL-C), and TC:HDL-C ratio did not differ on study days seven, 35 and 64. Plasma lipids concentrations were not affected by cherry consumption.

### ***Cross-sectional Studies***

**Mirmiran et al, 2009** (positive-quality), a cross-sectional study in Iran, evaluated the association of fruit and vegetable intake and CVD factors. Data (N=840; aged 18 to 74 years) from the Tehran Lipid and Glucose Study (TLGS) was used. Dietary intake was assessed using a semi-quantitative FFQ (168 items). Weight, height, medical history, physical activity and glucose and lipid concentrations were also measured. Mean consumption of fruit and vegetables was  $5.6 \pm 3.4$  servings per day. Subjects in the upper category of fruit and vegetable intake had lower TC, LDL-C, TC to HDL-C, and LDL-C/HDL-C as compared with those in the lower category. No significant differences were observed between HDL-C in category 1 (the lowest category) and those in category 4 of fruit and vegetable intake. Adjusted OR for high LDL-C concentrations were 1.00, 0.88, 0.81 and 0.75 (P for trend < 0.01; adjusted for age, sex, keys score, BMI, energy intake, smoking status, dietary cholesterol and history of diabetes mellitus and coronary artery disease); this trend was not appreciably altered by additional adjustment for education; physical activity; and saturated fat, polyunsaturated fat and total fat intakes. The authors concluded that consumption of fruits and vegetables was associated with lower concentrations of TC and LDL-C.

**Radhika et al, 2008** (positive quality), a population-based cross-sectional study, evaluated the association of fruit and vegetable intake with cardiovascular risk factors such as obesity, HTN, fasting plasma glucose and dyslipidemia in urban Asian Indians living in southern India. A total of 983 adults were included in the analysis. Dietary intake was assessed with an interviewer-administered semi-quantitative FFQ. Intake of fruit and vegetables ranged from 141g per day in the lowest quartile to 418g per day in the highest quartile. After adjusting for potential confounders, the highest quartile of fruit and vegetable intake showed a significant inverse association with TC ( $\beta = -50$ mg per L, 95% CI: -113.9, -13.6, P=0.017) and LDL-C ( $\beta = -55$ mg per L, 95% CI: -110.8, -11.1, P=0.039), when compared with the lowest quartile.


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## **Research Design and Implementation Rating Summary**

For a summary of the Research Design and Implementation Rating results, [click here](#).

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### **Worksheets**


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